

# Trends and Pattern of Crop Diversification in Kheri District, Uttar Pradesh, India

Moin Khan<sup>1</sup>, Dr. Ateeque Ahmad<sup>2</sup>

Department of Geography, Aligarh Muslim University, Aligarh-202002

**Abstract**— Crop diversification in India is visualized as the shift from traditionally cultivated less remunerative crops to more remunerative crops. The process of crop diversification is a result of government efforts, market conditions, and farmers' decisions according to the physical conditions of a particular area. The study has been carried out considering Lakhimpur Kheri district as the study area. The crop diversification was estimated by applying three techniques given by Gibbs and Martin, Bhatiya and Singh. Two agricultural years 2006-07 and 2016-17 are taken for the study. The study focused on the spatial comparison in which the block is the minimum unit area for the analysis. The maps for the spatial distribution of crop diversity are generated in the Arc GIS 10.2.2. A change in the crop diversification in a decade has also been examined. There was great similarity in the results by applying all the techniques, but there was some exception in some cases. The results show that, in 2006-07, the diversification was high in the northern and southern blocks like Nighasan, Dhaurehra, Isanagar, Mitauli, and Pasgawan while the blocks lying in the western and central region registered the low intensity of diversification. While, in 2016-17, southern blocks registered high crop diversification and the diversification was low in the central region in almost all the techniques applied.

**Keywords**— Crop diversification, Agriculture, Kheri District, Indian Agriculture.

## I. INTRODUCTION

Crop diversification, fundamentally, refers to the inclusion of a wider choice in the production of a variety of crops in a given area in order to accelerate the agricultural efficiency and to reduce risk (Papademetriou and Dent, 2001). Regional studies dealing with agricultural geography of a specific area in India illustrate the agricultural distribution in terms of their locale. Regional studies dealing with all of India have been so few and are so out of date that they are partly forgotten. Engelbrecht, in 1914, examined the distributional patterns of different crops with statistical analysis. Thus, it is the need of the hour to analyze the crop patterns of India from a regional perspective by focusing on the areal concentration and diversification of crops (Bhatiya, 1965; Radhakrishnan, 1930; Engelbrecht, 1914). Presently, Indian agriculture is passing through significant resource allocation. Two drastic phenomena that are occurring are crop diversification and agricultural-land conversion for industrialization. The policies of the government also shifting from the basic cereals to the production of so-called high value non-food commercial crops, mainly vegetables, fruits and flowers (Chakrabarti and Kundu, 2009). The period of 1970-71 to 2006-07 was a very crucial period in Indian agricultural history. The decade of the 1960s and 1970s witnessed the successful operation of the Green Revolution in a few selected areas of the economy followed by a significant change in the 1980s. The further decade of the 1990s affected by globalization led to the diversification of crops at the local level (Ghosh, 2011). The diversification of crops is very essential to generate agronomic, ecological, and risk management benefits. Cropping diversity helps to deal with the reduction in pest and disease pressures and increase nutrient cycling. These processes can decrease input requirements, enhance productivity, and reduce environmental threats from high fertilizer and pesticide applications. A shortcoming of crop diversification is potentially enhanced production risk associated with mastering the technology and biology of new crops (Smith and Young, 2003). However, agricultural diversification is seen as a possible solution for rural poverty, as distinct from the objective of strengthening the national economy (Courtenay, 1984).

## II. LITERATURE REVIEW

Mandal and Dutta (1993) assessed the role of irrigation in the crop diversification in special reference to rice-based systems in Bangladesh. It has been found that the irrigation in the non-rice crops is more profitable than Boro rice. Thus, the 'vital input' for such a non-rice crop is irrigation. Although the irrigation practices were introduced in order to enhance rice production, therefore it is not appropriate for non-rice crops in the rice-based system. Zohir (1993) presumes crop

diversification to imply a greater relative emphasis on non-cereal production. In the context of agricultural scenario in Bangladesh, a farmer may cultivate all crops except rice and wheat; and an increase in their relative share in cultivated land may be characterized by enhanced crop diversification. Singh and Sidhu (2004) pointed out a very interesting fact about the agricultural pattern of Punjab. The diversified cropping pattern of Punjab drastically changed into a wheat-rice specialization over the past few decades. The diversity of crops tends to decline with time, which is a serious concern for the overuse of natural resources, ecological problems, aquifer crisis, and growing income risk. Blank (1990) suggested a new single index model (SIM) application procedure which makes ease for the user to examine the risk/return trade-off among crop portfolios. A new performance estimate is derived from the SIM to aid in ranking crop portfolios based on that trade-off. Mandal (2010) examined the cropping patterns risk management in the flood plains of Assam. The crop-growing sector in Assam is faced with higher risk and uncertainty due to frequent floods every year causing great damage to crops, livestock, and property. In such conditions, the farmers are forced to adjust the cropping pattern and cropping season to some extent.

### III. OBJECTIVES

The objectives of this study are as follows:

- To examine the crop diversification in different blocks of Kheri district.
- To make a comparison of crop diversification in 10 years by using different techniques.

### IV. METHODOLOGY

In the present study different techniques as to be adopted to examine the crop diversification of different areas at different times. Three main techniques have been used to make a comparison of crop diversification in different blocks to acquire more accuracy in the results. The first technique is used given by Gibbs and Martin, The second technique is applied proposed by Bhatia and the last technique is implemented is given by Singh. the detail description of these techniques has been put the following:

#### 4.1 Gibbs and Martin's Method for Demarcating Crop Diversification Regions

$$\text{Index of Crop Diversification} = 1 - \frac{\sum X^2}{(\sum X)^2}$$

Where X is the percentage of total cropped area under an individual crop. In this technique 0 represents no diversification or monoculture and 1 represents the highest possible diversification.

#### 4.2 Bhatia's Method for Demarcating Crop Diversification Regions

$$\text{Index of Crop Diversification} = \frac{\text{Total Cropped Area Under } x \text{ Crops}}{\text{Number of 'n' Crops}}$$

Where 'x' stands for those crops which individually occupy 10 percent or more of the total cropped area. The high index value represents low diversification and low index value demonstrates the high diversification.

#### 4.3 Singh's Method for Demarcating Crop Diversification Regions

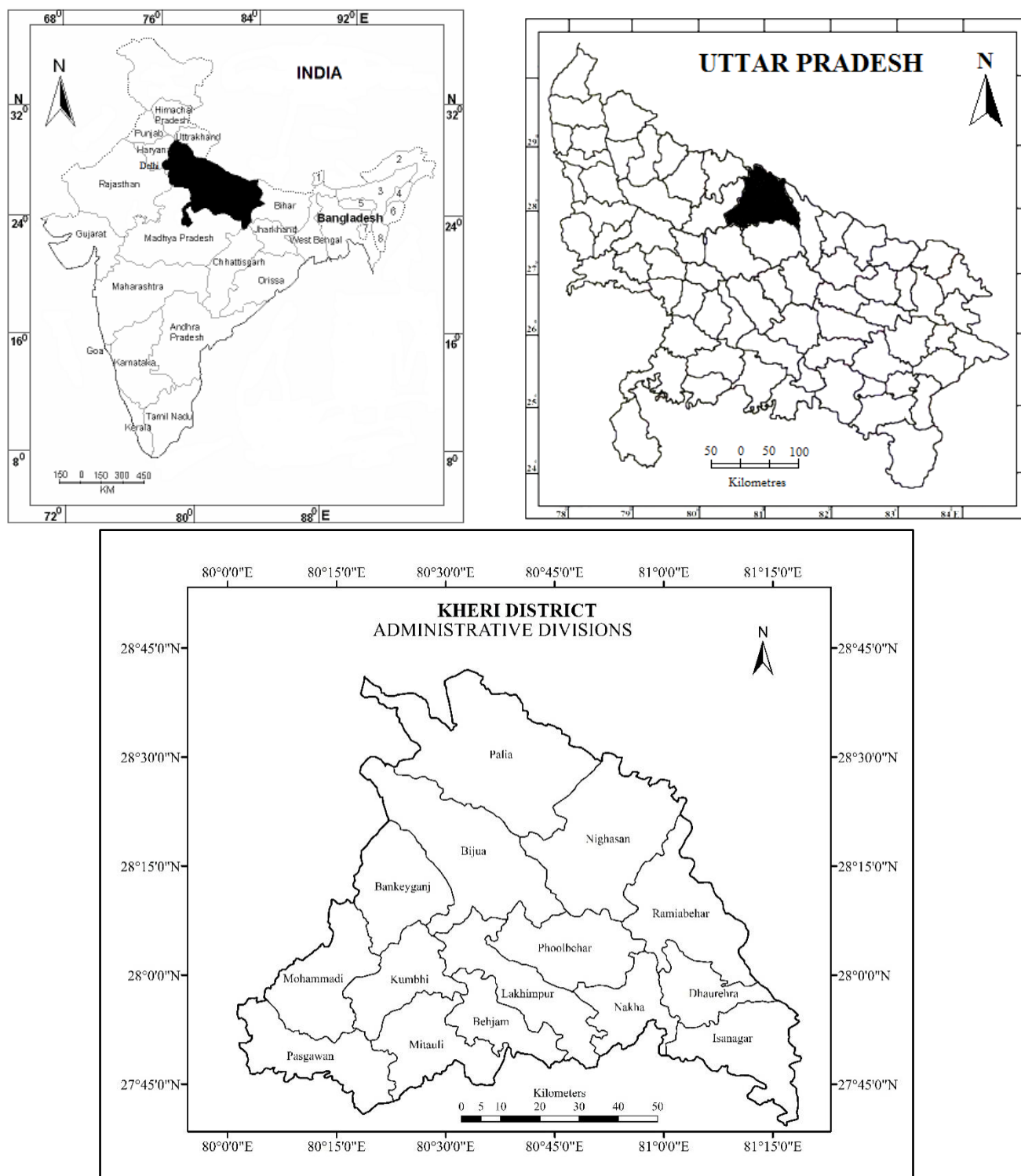
$$\text{Index of Crop Diversification} = \frac{\text{Percentage of total harvested area under 'n' crops}}{\text{Number of 'n' crops}}$$

Where 'n' crops are those which individually occupy 5 percent or more of the total harvested area. Similar to Bhatiya's technique, the high index value represents low diversification and vice versa.

### V. STUDY AREA

Lakhimpur Kheri District of Uttar Pradesh state has been taken as the study area for this study. Kheri is the largest district in Uttar Pradesh, lying along the Indo-Nepal Border. It is located in the Terai belt of Indo Gangetic Plain; moreover, the district has been placed in Eastern Uttar Pradesh, regionally. Kheri district has its headquarters in the city of Lakhimpur. Kheri district is roughly triangular in shape, pointing its apex towards the north; it is a part of Lucknow division. Kheri district

sprawls between the parallels of 27°41' and 28°42'N latitudes and 80°2' and 81°19'E latitudes. Kheri District has an area of 7680 km<sup>2</sup>, ranking first in size in the state.



**FIGURE 1: Study Area (Kheri District, Uttar Pradesh, India)**

## VI. RESULT AND DISCUSSION

The cropping pattern of Kheri district has been scaled by various techniques to examine the diversification of cropping pattern. The methods of Gibbs & Martin, Bhatia and Singh have been applied to blockwise data of Kheri district. The results acquired from these techniques are choroplethed in the maps and analyzed as follow:

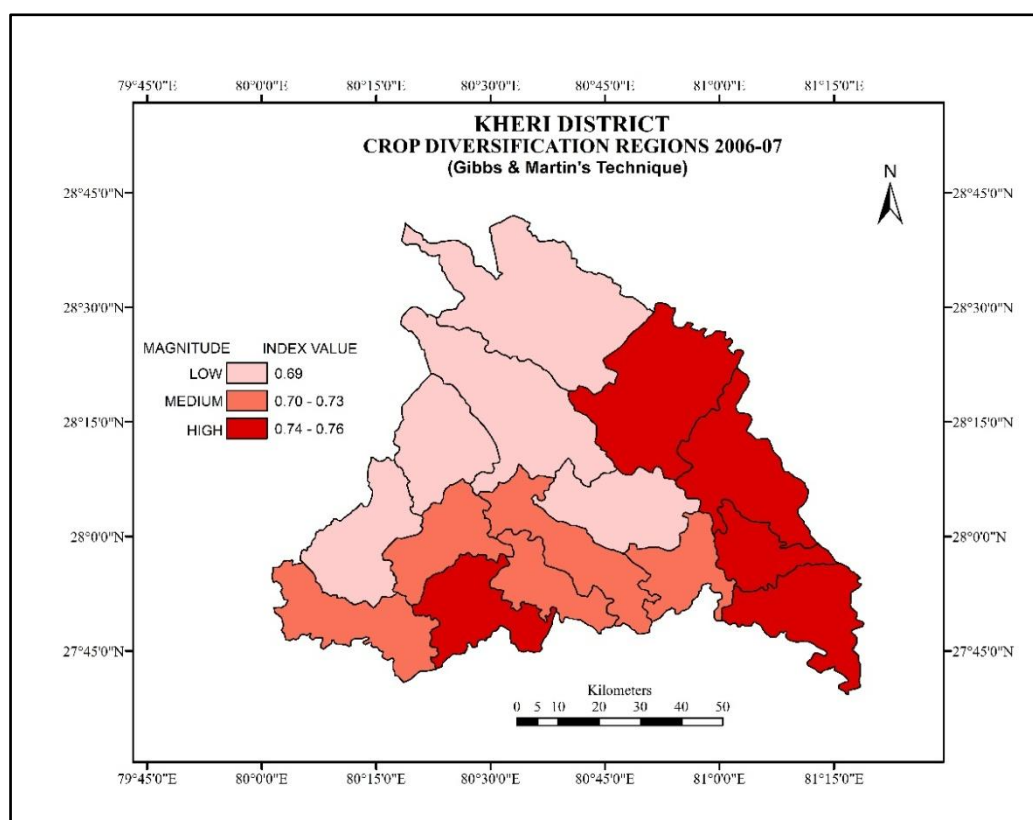
### 6.1 Crop Diversification (2006-07)

The calculation made by the Gibbs and Martin's formula, the crop diversification in the district was estimated as 0.74 in 2006-07. The index varies from 0.69 in Palia block to 0.76 in Dhaurehra block recording highest diversification in the cropping pattern. The whole district has been divided into three categories by chroplething on the map.

**TABLE 1**  
**CROP DIVERSIFICATION INDEX, KHERI DISTRICT, UTTAR PRADESH 2006-07**

| Blocks         | Gibbs & Martin | Bhatiya      | Singh        |
|----------------|----------------|--------------|--------------|
| Palia          | 0.69           | 29.13        | 23.56        |
| Nighasan       | 0.75           | 27.96        | 19.24        |
| Ramiyabehar    | 0.75           | 28.92        | 23.03        |
| Kumbhi         | 0.74           | 28.92        | 23.82        |
| Bijua          | 0.72           | 30.57        | 30.57        |
| Bankeyganj     | 0.71           | 30.91        | 30.91        |
| Mohammadi      | 0.72           | 29.72        | 29.72        |
| Mitauli        | 0.75           | 28.38        | 19.46        |
| Pasgawan       | 0.74           | 28.45        | 23.51        |
| Behjam         | 0.73           | 29.85        | 29.85        |
| Lakhimpur      | 0.73           | 29.29        | 29.29        |
| Phoolbehar     | 0.72           | 30.37        | 30.37        |
| Nakha          | 0.73           | 29.29        | 23.31        |
| Dhaurehra      | 0.76           | 22.81        | 19.35        |
| Isanagar       | 0.75           | 26.59        | 16.51        |
| Kheri District | <b>0.74</b>    | <b>28.93</b> | <b>23.26</b> |

*Source: computed by author from District Statistical magazine, Kheri District-2006-07*

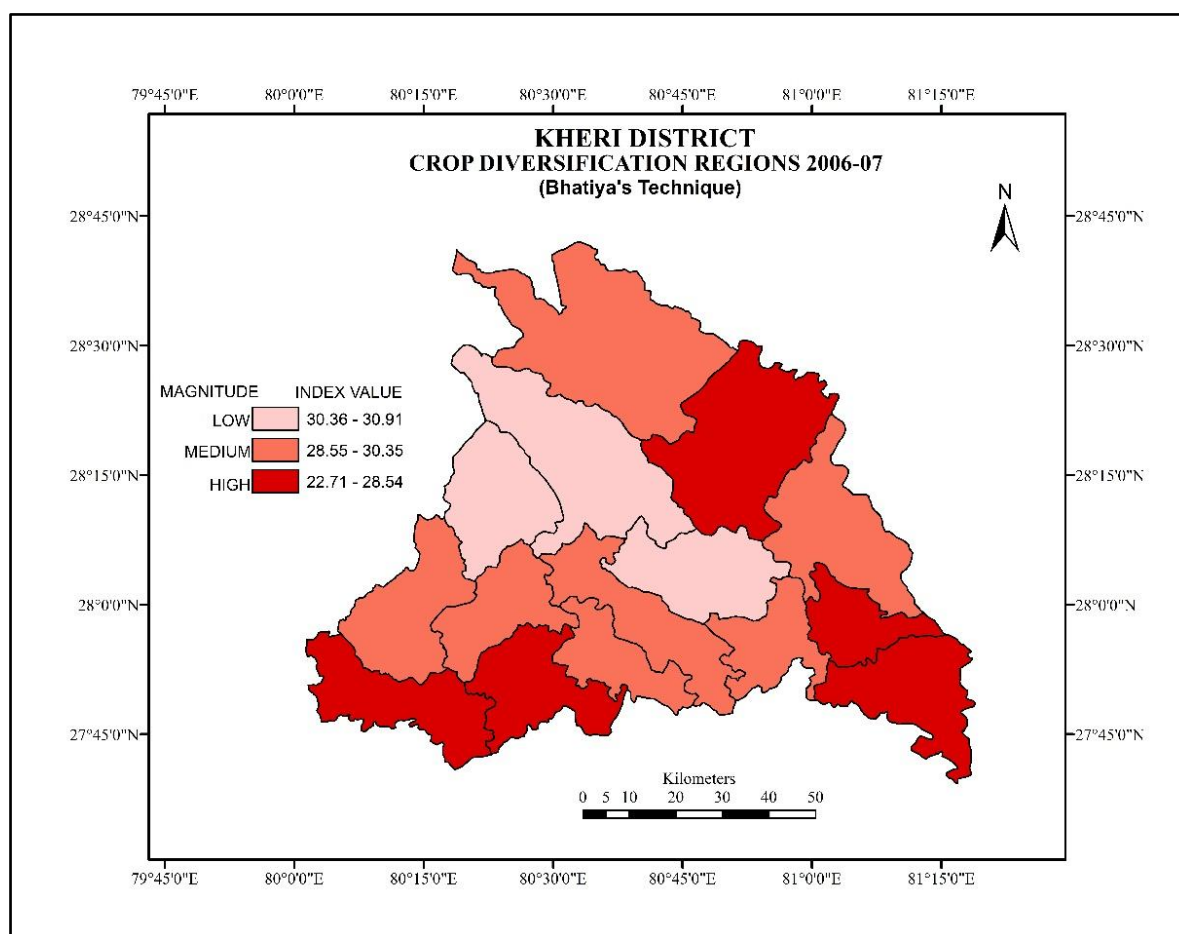


**FIGURE 2: Crop Diversification Index after Gibbs & Martin**

### 6.1.1 Area of high crop diversification

The blocks of Nighasan, Ramiabehar, Dhaurehra, and Isanagar lying in the Tarai region along the border of Nepal were indexed in the high diversification in the cropping pattern according to the Gibbs and Martin's technique (Fig 2). Besides these, Mitauli block in the southern boundary of the district also registered high diversification of the crops. All these blocks have good availability of river water throughout the year, flat floodplain rejuvenated every year by the rivers, and an adequate amount of rainfall, which supports the maximum number of crops in the district. But in the case of Mitauli, the maximum crops are grown by farmers to cope with the risk of monsoon failure.

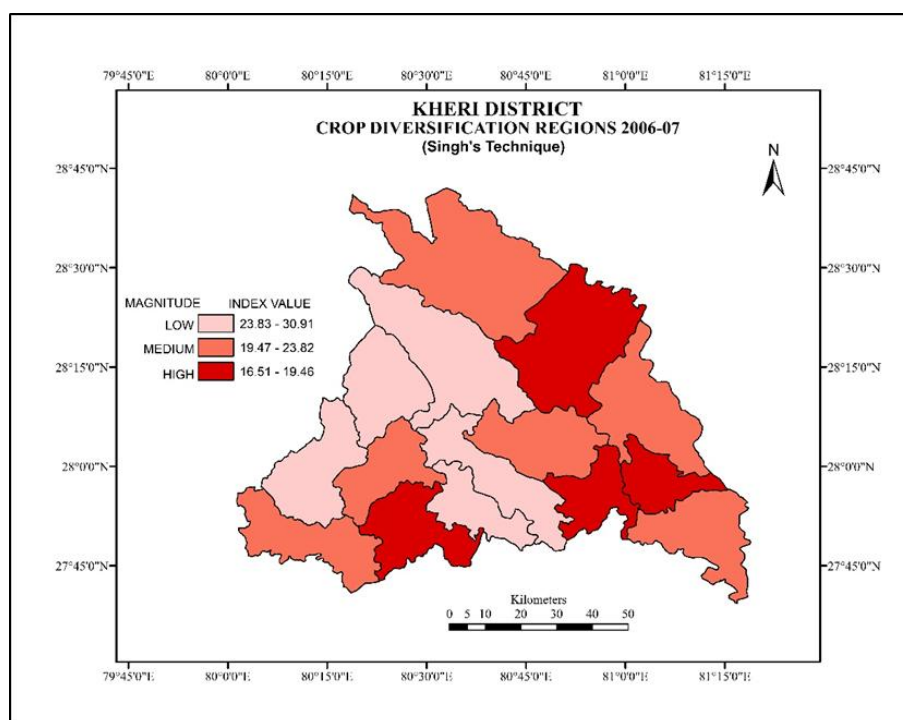
The application of Bhatiya's technique (fig 3) finds out that high crop diversification prevails in Nighasan, Dhaurehra, Isanagar, Mitauli and Pasgawan block where index varies from 22.71 to 28.54. According to Singh's technique (fig 4), the high crop diversification lies in Nighasan, Dhaurehra, Nakha and Mitauli Blocks. Thus, it is clear from the results shown in the map that the area of high diversification is quite similar in all the indexes



**FIGURE 3: Crop Diversification Index after Bhatiya**

### 6.1.2 Area of Moderate Crop Diversification

According to Gibbs and Martin's technique, the moderate crop diversification indexed between 0.70 and 0.73 has been registered in the blocks of Pasgawan, Kumbhi, Behjam, Lakhimpur and Nakha. In these blocks, the farmers cultivate only those crops which respond well in the prevailing physical conditions of these areas. The rain fed crops are generally cultivated in the monsoon season i.e. groundnut, urad, sesamum, barley, and vegetables. In Bhatiya's index, the moderate diversification of crops lies between the index value of 28.55 and 30.35. Applying this technique, seven blocks were reported to have moderate diversification of crops. These blocks comprised Palia, Ramiabehar, Nakha, Lakhimpur, Behjam, Mitauli and Mohammadi. While the results by applying Singh's techniques are slightly different. In this index, the moderate diversification is registered between the index values of 19.47-23.82. Hence, six blocks were registered with moderate crop diversification. These blocks consisted of Palia, Ramiabehar, Isanagar, Phoolbehar, Kumbhi, and Pasgawan.



**FIGURE 4: Crop Diversification Index after Singh**

### 6.1.3 Area of Low Diversification

According to Gibbs and Martin's technique, the low crop diversification was recorded in the index up to 0.69. There were five blocks in the district which were experiencing the low crop diversification. These blocks were Palia, Bankeyganj, Phoolbehar, Bijua and Mohammadi. While in Bhatiya's index of diversification, the low diversification of crop was scaled between 30.36 and 30.91. Only three blocks fell into this category namely Bijua, Phoolbehar and Bankeyganj. With the application of Singh's technique, the low diversification of crop is scaled between the index values of 23.83-30.9. The low crop diversification, in this index, was found in five blocks. These blocks consisted of Bijua, Lakhimpur, Behjam, Bankeyganj and Mohammadi. Thus from the above analysis, it has been pointed out that the low diversification of crop was dominant in Bijua and Bankeyganj by applying all the techniques.

**TABLE 2**  
**CROP DIVERSIFICATION INDEX, KHERI DISTRICT, UTTAR PRADESH 2016-17**

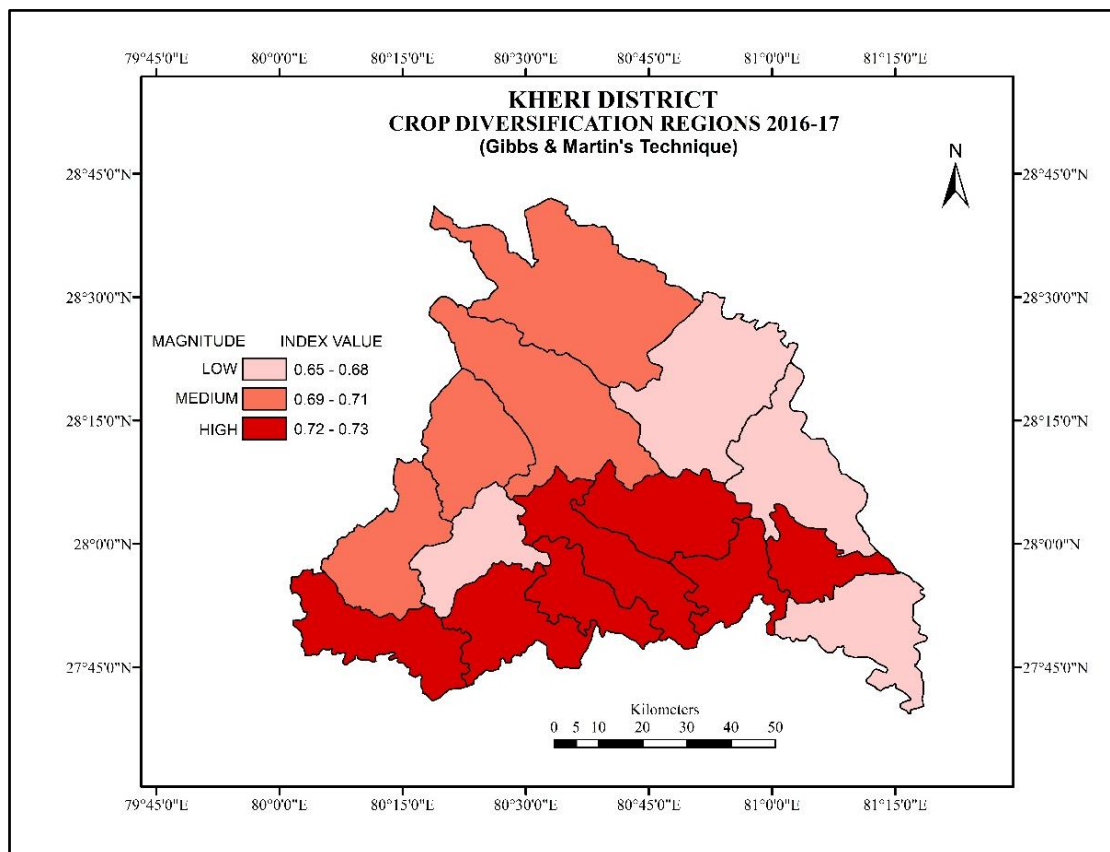
| Blocks         | Gibbs and Martin's Index | Bhatiya's Index | Singh's Index |
|----------------|--------------------------|-----------------|---------------|
| Palia          | 0.69                     | 23.75           | 23.75         |
| Nighasan       | 0.66                     | 30.81           | 30.81         |
| Ramiyabehar    | 0.66                     | 30.18           | 30.18         |
| Kumbhi         | 0.67                     | 29.73           | 23.89         |
| Bijua          | 0.69                     | 30.55           | 30.55         |
| Bankeyganj     | 0.71                     | 31.17           | 31.17         |
| Mohammadi      | 0.69                     | 30.09           | 30.09         |
| Mitauli        | 0.72                     | 29.03           | 23.41         |
| Pasgawan       | 0.72                     | 29.24           | 23.53         |
| Behjam         | 0.73                     | 29.51           | 23.41         |
| Lakhimpur      | 0.73                     | 29.76           | 29.76         |
| Phoolbehar     | 0.72                     | 30.56           | 30.56         |
| Nakha          | 0.72                     | 29.06           | 23.28         |
| Dhaurehra      | 0.72                     | 28.40           | 22.66         |
| Isanagar       | 0.65                     | 27.80           | 24.19         |
| Kheri District | <b>0.72</b>              | <b>29.70</b>    | <b>23.59</b>  |

*Source: computed by the author from District Statistical magazine, Kheri District, 2016-17*



## 6.2 Crop Diversification (2016-17)

A comparison of crop diversification has been made of a decade. The data of 2016-17, after 10 years from 2006-07 has been analyzed to examine crop diversification in different blocks of Kheri district. Three techniques are adopted to scale the level of diversification in the district i.e. Gibbs and Martin's technique, Bhatiya's technique, and Singh's technique. All the blocks are stratified in three categories-high, medium and low following the indices are given by these scholars.



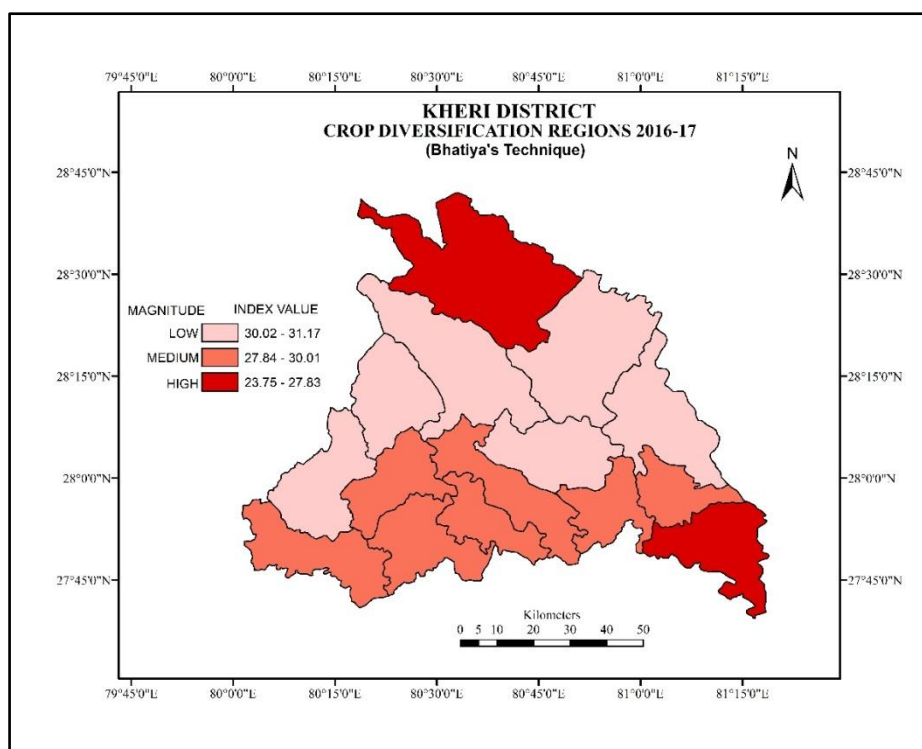
**FIGURE 5 Crop Diversification Index after Gibbs & Martin**

### 6.2.1 Areas of High Diversification

Gibbs and Martin's index (Fig 5) categorized the high diversification of the crops between the index value of 0.72 and 0.73. On this basis of this technique, seven blocks are identified as the highly diversified area in terms of crop cultivation. Pasgawan, Mitauli, Behjam, Lakhimpur, Phoolbehar, Nakha, and Dhaurehra blocks were reported high crop diversification. In Bhatiya's technique (Fig 6), the high diversification was scaled between 23.75 and 27.83 in the index. Only two blocks were identified to have high crop diversification i.e. Palia and Isanagar. While considering Singh's technique (fig 7) of crop diversification, the index of high diversification ranged from 22.66 to 24.19. As a result, eight blocks fell in this category of high diversification. These blocks were identified as Palia, Dhaurehra, Isanagar, Nakha, Behjam, Kumbhi, Mitauli and Pasgawan.

### 6.2.2 Areas of Moderate Diversification

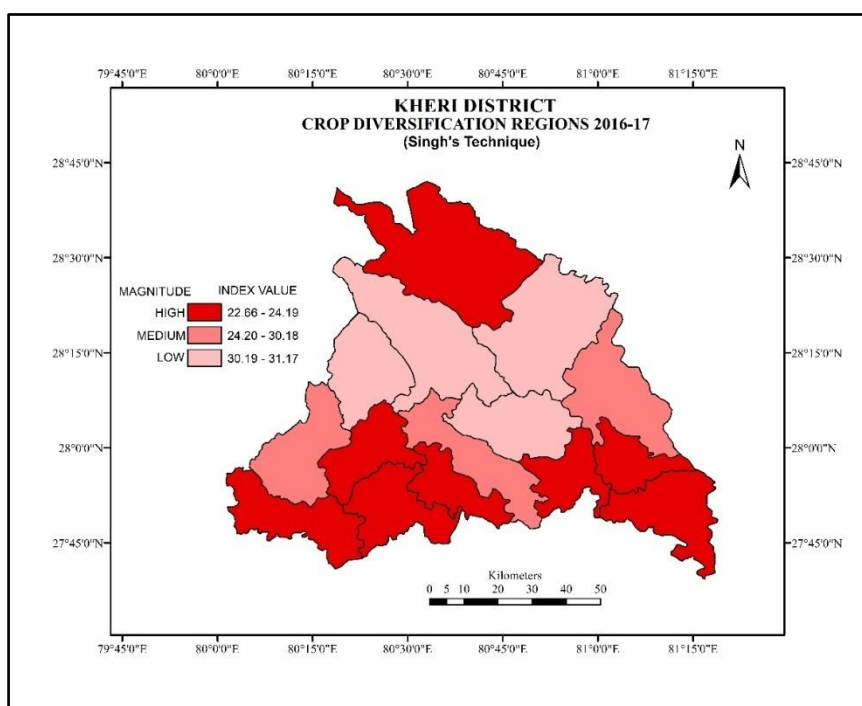
The areas of moderate diversification have been scaled by Gibbs and Martin's technique between the value between 0.69 and 0.71 values in the index. Based on this technique, four blocks are recognized as the blocks of moderate diversification in the district. These blocks consisted of Palia, Bijua, Bankeyganj, and Mohammadi. On the other hand, Bhatiya's technique ranged between 27.84 and 30.01 to depict the moderate diversification of the crops. Interestingly, all the southern crops are fallen in this category. These blocks are Dhaurehra, Nakha, Lakhimpur, Behjam, Kumbhi, Mitauli and Pasgawan. While applying Singh's technique, the index of moderate crop diversification scaled between 24.20 and 30.18. Only three blocks are laying in this category i.e. Ramiabehar, Lakhimpur and Mohammadi.



**FIGURE 6: Crop Diversification Index after Bhatiya**

### 6.2.3 Areas of Low Diversification

According to Gibbs and Martin's technique, the low diversification of crops has been demonstrated in the choropleth map between 0.65 and 0.68. The total number of blocks in this category was four i.e. Nighasan, Ramiabehar, Isanagar and Kumbi. While applying Bhatiya's technique the diversification of crop is low between 30.02 and 31.17 in the index. A total of six blocks fell in these categories which are Mohammadi, Bankeyganj, Bijua, Phoolbehar, Nighasan, and Ramiabehar. While applying Singh's technique the low diversification of crops has been ranged between the value of 30.19 and 31.17 in the index. Low crop diversification was identified in for blocks according to this technique these blocks are Bankeyganj, Bijua, Phoolbehar, and Nighsan.



**FIGURE 7: Crop Diversification Index after Singh**



**TABLE 3**  
**CHANGES IN THE CROP DIVERSIFICATION IN KHERI DISTRICT BETWEEN 2006-07 AND 2016-17**

| Blocks         | Gibbs and Martin's Index |             | Bhatiya's Index |              | Singh's Index |              |
|----------------|--------------------------|-------------|-----------------|--------------|---------------|--------------|
|                | 2006-07                  | 2016-17     | 2006-07         | 2016-17      | 2006-07       | 2016-17      |
| Palia          | 0.69                     | 0.69        | 29.13           | 23.75        | 23.56         | 23.75        |
| Nighasan       | 0.75                     | 0.66        | 27.96           | 30.81        | 19.24         | 30.81        |
| Ramiyabehar    | 0.75                     | 0.66        | 28.92           | 30.18        | 23.03         | 30.18        |
| Kumbhi         | 0.74                     | 0.67        | 28.92           | 29.73        | 23.82         | 23.89        |
| Bijua          | 0.72                     | 0.69        | 30.57           | 30.55        | 30.57         | 30.55        |
| Bankeyganj     | 0.71                     | 0.71        | 30.91           | 31.17        | 30.91         | 31.17        |
| Mohammadi      | 0.72                     | 0.69        | 29.72           | 30.09        | 29.72         | 30.09        |
| Mitauli        | 0.75                     | 0.72        | 28.38           | 29.03        | 19.46         | 23.41        |
| Pasgawan       | 0.74                     | 0.72        | 28.45           | 29.24        | 23.51         | 23.53        |
| Behjam         | 0.73                     | 0.73        | 29.85           | 29.51        | 29.85         | 23.41        |
| Lakhimpur      | 0.73                     | 0.73        | 29.29           | 29.76        | 29.29         | 29.76        |
| Phoolbehar     | 0.72                     | 0.72        | 30.37           | 30.56        | 30.37         | 30.56        |
| Nakha          | 0.73                     | 0.72        | 29.29           | 29.06        | 23.31         | 23.28        |
| Dhaurehra      | 0.76                     | 0.72        | 22.81           | 28.40        | 19.35         | 22.66        |
| Isanagar       | 0.75                     | 0.65        | 26.59           | 27.80        | 16.51         | 24.19        |
| Kheri District | <b>0.74</b>              | <b>0.72</b> | <b>28.93</b>    | <b>29.70</b> | <b>23.26</b>  | <b>23.59</b> |

*Source: Computed by the author, 2019*

Table 3 shows the change in crop diversity during the period of 10 years. This comparative analysis helps to understand the pattern of crop diversification in two different years. Considering Gibbs and Martin's technique, in the year 2006-07, Dhaurehra block registered the highest diversification of crops with an index value of 0.76, while, Palia was the least in crop diversity with an index value of 0.69. Applying the same technique, in the year 2016-17, Lakhimpur and Behjam recorded the highest crop diversification, however, Isanagar was the at the bottom. In Bhatiya's technique, in the year 2006-07, Dhaurehra was at the top in terms of crop diversity with an index value of 26.59 and Bankeyganj block was at the lowest in crop diversity having the index value of 30.91. Using the same technique, in the year 2016-17, Palia registered the highest crop diversity with an index value of 23.75, on the other hand, Bankeyganj was at the bottom line with an index value of 31.17. Similarly in Singh's index of crop diversification, in 2006-07, Isanagar experienced the highest crop diversity with an index value of 16.51 and Bankeyganj block was leading in crop specialization with an index value of 30.91. While in the year 2016-17, the crop diversification, using Singh's technique, Dhaurehra registered the highest crop diversity with an index value of 22.66, and Bankeyganj block was at the bottom in terms of crop diversification scaling 31.17 index values.

## VII. CONCLUSION

The findings of the study show that the intensity of crop diversification in all the blocks quite lies in the same range. In some cases, the differences are found, which is due to the differences in the formulas of various techniques. The blocks lying in the high crop diversity may be slipped to moderate in the other technique's application but it did not fell in the category of low diversification and vice versa. Thus, all the techniques depict the resembling picture of diversification in the 15 blocks of the Kheri district. The results suggested that, in 2006-07, the diversification was recorded high in the northern and southern blocks like Nighasan, Dhaurehra, Isanagar, Mitauli, and Pasgawan while the blocks lying in the western and central region registered the low intensity of diversification. While, in 2016-17, southern blocks registered high crop diversification and the diversification was low in the central region in almost all the techniques applied.

## REFERENCES

- [1] B.K. Ghosh, Determinants of the Changes in Cropping Pattern in India: 1970-71 to 2006-07, The Bangladesh Development Studies, Vol. 34, No. 2 (June 2011), pp. 109-120
- [2] E.G. Smith, and D.L. Young, Cropping Diversity along the U.S.-Canada Border, Review of Agricultural Economics, Vol. 25, No. 1 (Spring - Summer, 2003), pp. 154-167
- [3] Engelbrech, Agricultural Regions of Asia, Part IV: India," Econ. Geog., Vol. 9, 1933, pp. 109-136
- [4] J. Singh, and R.S. Sidhu, Factors in Declining Crop Diversification: Case Study of Punjab, Economic and Political Weekly, Vol. 3, 9No. 52 (Dec. 25-31, 2004), pp. 5607-5610
- [5] K.S. Ahmad, Geographical factors in the production and distribution of wheat in the Panjab, and distribution of wheat in the Panjab," Calcutta Geogra. Rev., Vol. 4, 1942, pp. 124-146

- 
- [6] M. K. Papademetriou, and F.J. Dent, Crop Diversification in The Asia-Pacific Region, Food And Agriculture Organization of The United Nations Regional Office for Asia And The Pacific Bangkok, Thailand, April 2001, RAP Publication: 2001/03
- [7] M.A.S. Mandal, and S.C.Dutta, Irrigation for Crop Diversification in Rice-based Systems in Bangladesh, The Bangladesh Development Studies, Vol. 21, No. 3, Crop Diversification in Bangladesh (September 1993), pp. 91-100
- [8] P.P.Courtenay, The Diversification of Malaysian Agriculture, 1950-80: Objectives and Achievements, Journal of Southeast Asian Studies, Vol. 15, No. 1 (Mar., 1984), pp. 166-181
- [9] R. Mandal, Cropping Patterns and Risk Management in the Flood Plains of Assam, Economic and Political Weekly, Vol. 45, No. 33 (August 14-20, 2010), pp. 78-81
- [10] S. Chakrabarti, and A. Kundu, Rural Non-Farm Economy: A Note on the Impact of Crop-Diversification and Land Conversion in India, Economic and Political Weekly, Vol. 44, No. 12 (Mar. 21 - 27, 2009), pp. 69-75
- [11] S. Zohir, Problems and Prospects of Crop Diversification in Bangladesh, The Bangladesh Development Studies, Vol. 21, No. 3, Crop Diversification in Bangladesh (September 1993), pp. 73-90
- [12] S.C. Blank, Returns to Limited Crop Diversification, Western Journal of Agricultural Economics, Vol. 15, No. 2 (December 1990), pp.204-212.
- [13] S.S.Bhatiya, Patterns of Crop Concentration and Diversification in India, Economic Geography, Vol. 41, No. 1 (Jan., 1965), pp. 39-56.